

Eye tracking: an underused diagnostic tool with wide clinical potential



At a time when digital diagnostics are rapidly entering clinical practice, one established source of objective clinical data remains conspicuously overlooked: eye tracking. Eye tracking is a precise method for evaluating motor control and cognitive processes. Eye movements are less constrained by biomechanics than other body movements, and the neural circuits controlling them are among the best characterised in the nervous system.^{1,2} Eye tracking has the potential to improve patient diagnosis and monitoring in many clinical contexts. For example, eye tracking can quantify disease progression in Alzheimer's disease, Parkinson's disease, Huntington's disease, and neurodegenerative dementias.³ Eye tracking can help to identify and monitor mild traumatic brain injury,⁴ quantify social attention deficits in autism,⁵ support the diagnosis and monitoring of multiple sclerosis,⁶ and facilitate the early diagnosis of corticobasal degeneration and progressive supranuclear palsy.⁷ A substantial body of research supports the integration of eye tracking into neurology, ophthalmology, optometry, and psychiatry practice.

Despite the wealth of research evidence showing their clinical value, eye trackers are not widely used in clinical settings. Only a few clinics use eye tracking as part of routine clinical practice, because several factors hold back its widespread adoption. Here, we summarise current practice among major UK clinics already delivering eye-tracking services and set out the steps required for eye tracking to fulfil its potential as a routinely used clinical tool.

In clinical settings, eye-tracking paradigms will depend on the patient's presentation and can include assessments of fixation stability, smooth pursuit, saccades (including latency and speed), and reflexive responses. For example, optokinetic nystagmus and the vestibulo-ocular reflex, including head-impulse testing and whole-body rotational responses, are often tested in vestibular neurology clinics. Antisaccades can also assess frontal executive dysfunction. A detailed description of eye movement tests and their clinical applications has been provided by Giacomini and colleagues.⁸

A specific subset of eye tracking, videonystagmography, is available in some neuro-otology clinics to help diagnose

central and peripheral vestibular dysfunction. Videonystagmography measures involuntary eye movements (nystagmus) in response to head movements and caloric stimulation. Measurement of ocular torsion with three-dimensional videonystagmography in response to sound or pressure stimuli can support the diagnosis of superior semicircular canal dehiscence. Even in this well established use case, training in vestibular assessment, including the performance and interpretation of videonystagmography and related bedside examinations, is scarce: vestibular neurology is not included as a core competency in neurology training curricula despite documented associations between inadequate expertise, diagnostic errors, and poor patient outcomes.⁹

Specific scenarios in which eye tracking can inform patient management include differentiating progressive supranuclear palsy from Parkinson's disease, showing reflexive eye movements in infants who are visually unresponsive, early diagnosis of Niemann–Pick Type C, and differential diagnosis of nystagmus, which could avoid the need for infants to undergo neuroimaging under general anaesthesia.

In the absence of agreed guidance, the few clinics using eye tracking have developed individual approaches, resulting in substantial variation in practice. Some clinics have developed bespoke software to analyse eye movement recordings, whereas others use proprietary built-in tools that are not optimised for clinical workflows. There also appears to be no consensus on the most appropriate eye-tracking hardware for clinical use: among the nine clinics represented by the authors of this Comment, 11 different eye trackers are used.

Eye trackers are beginning to be integrated into clinical workflows, but delivery is inconsistent, and standardised protocols have yet to be developed. Because clinics typically develop bespoke protocols for their specific hardware, this lack of standardisation prevents meaningful comparison of results across clinics and limits continuity when patients move between clinics. The lack of standard protocols is also a major barrier to clinicians wishing to enter the field.

Although eye movement assessment has historically been performed without objective digital recording, eye

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Panel: Barriers to clinical eye tracking and steps needed to scale eye tracking as a clinical discipline

Barriers

- Lack of standardised protocols
- Lack of reference datasets
- Eye-tracking devices and software are rarely certified for clinical use
- Low awareness of the value of clinical eye tracking among clinicians
- Inconsistent clinical tariffs or fee codes
- Inadequate training in eye-tracker operation and interpretation of results, as these competencies are not routinely incorporated into standard medical training
- Poor understanding of the value of eye tracking in health systems, given the small number of users at present
- Insufficient dedicated space for an eye tracker, particularly in shared clinics; frequent movement of equipment prolongs daily setup time

Steps needed

- Greater awareness of the evidence showing the clinical utility of eye tracking
- Standardised clinical protocols
- Measurements of reproducibility across clinics
- Reference (normative) datasets with diagnostic thresholds
- Cross-platform eye-tracking data formats for incorporation into patient records
- Eye-tracking devices and software certified for clinical use
- Training programmes
- Unified clinical tariffs for eye tracking

trackers can reduce subjectivity and the likelihood that subtle abnormalities are missed. In one validation study, eye trackers performed comparably to a clinician-administered examination in detecting abnormal eye movement.¹⁰ In another study, eye tracking identified mild internuclear ophthalmoplegia that a median 71% of 279 physician evaluators missed.¹¹ However, the increased diagnostic precision provided by quantitative eye-tracking analyses is clinically useful only when supported by clearly defined reference datasets based on open and standardised protocols, which have yet to be established, to ensure applicability across devices, platforms, and clinical settings.

Another issue for prospective users is that many eye trackers are not certified as medical devices, and their software is not approved for clinical use. In such cases, the clinical use of eye trackers would generally fall outside the manufacturer's intended purpose. The problem is self-reinforcing: lack of certification deters clinicians from using eye trackers, and the small user base makes it difficult for manufacturers to justify seeking certification across multiple jurisdictions. By contrast, the CE marking is more common for devices designed for videonystagmography.

Difficulty in obtaining reimbursement for eye-tracking assessments can also be a barrier to their use, depending on the funding model. In the UK, for example, tertiary clinics might be funded through block contracts, whereas

other clinics need to claim reimbursement for individual tests. Eye tracking is often not assigned an appropriate reimbursement code, and resolving such coding issues can take years.

The major barriers to wider clinical uptake of eye-tracking technology and the steps needed for eye tracking to become a mainstream clinical discipline are listed in the panel. Eye trackers are not being used to their full clinical potential. Although substantial research evidence shows the potential benefits of eye trackers, wider adoption is needed to establish their impact when incorporated into routine clinical pathways.

The International Society for Clinical Eye Tracking (ISCET) was established in 2023 to build international consensus on standardised clinical protocols, generate reference datasets with clear diagnostic thresholds, and establish open-source eye-tracking data formats that allow data from different platforms to be incorporated into health records. These efforts aim to reduce fragmentation across clinics and lower barriers for clinicians entering the field. However, professional coordination alone will not be sufficient. Manufacturers should obtain certification for their devices for clinical use, and health-system stakeholders will need to ensure that eye-tracking assessments are assigned appropriate reimbursement codes.

For more on the International Society for Clinical Eye Tracking see <https://clinicaleyetracking.org/>

Eye tracking has the potential to improve routine care by supplementing qualitative observation with objective, quantitative measurements that can be repeated over time and analysed automatically. With appropriate standards and training, eye tracking can be scaled across numerous clinical disciplines, improving diagnostic accuracy across a range of conditions and enabling objective monitoring of disease progression and treatment response. Coordinated action is required to achieve this potential, but the benefits of clinical eye tracking are within reach.

MJD is the founder and General Coordinator of ISCET and received funding from Cardiff University to visit eye-tracking clinics for the preparation of this Comment. GA is the Editor-in-Chief of the *British and Irish Orthoptic Journal*, is a member of the British and Irish Orthoptic Society Council, and is Membership Secretary and a committee member of the British Isles Paediatric Ophthalmology and Strabismus Association. DA is a member of the clinical advisory board of Siloton and is being loaned an eye tracker by Bulbitech. BMS is paid by EU European Space Agency to review grant applications and is a member of the Association of British Neurologists, British Society of Neuro-Otology and European Academy of Neurology committees. All other authors declare no competing interests.

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